Coal Mine Methane Recovery & Utilization in the United States:

CMOP's Coal Mine Methane Project Cash Flow Model

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- **CMOP Mission: to work with the coal mining and related industries to reduce CMM emissions cost-effectively**
- What we do in a nutshell:
  - Identify profitable opportunities for project development
  - Identify and help overcome market, regulatory, and technical barriers
  - Offer technical and analytic support where appropriate
  - Conduct direct outreach to coal mines
- **Need for a tool to analyze CMM project costs and benefits**

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- **Coal Mine Methane Project Cash Flow Model**
  - Goal: user-friendly, attractive, informative, and useful
  - Assembled a team of economists, programmers, and CMM industry specialists with on-the-ground experience
  - Carefully selected six end-uses for U.S. market
  - Surveyed external industry experts for specific default and recommended parameters
  - Conducted internal and third-party review to ensure operability and accuracy

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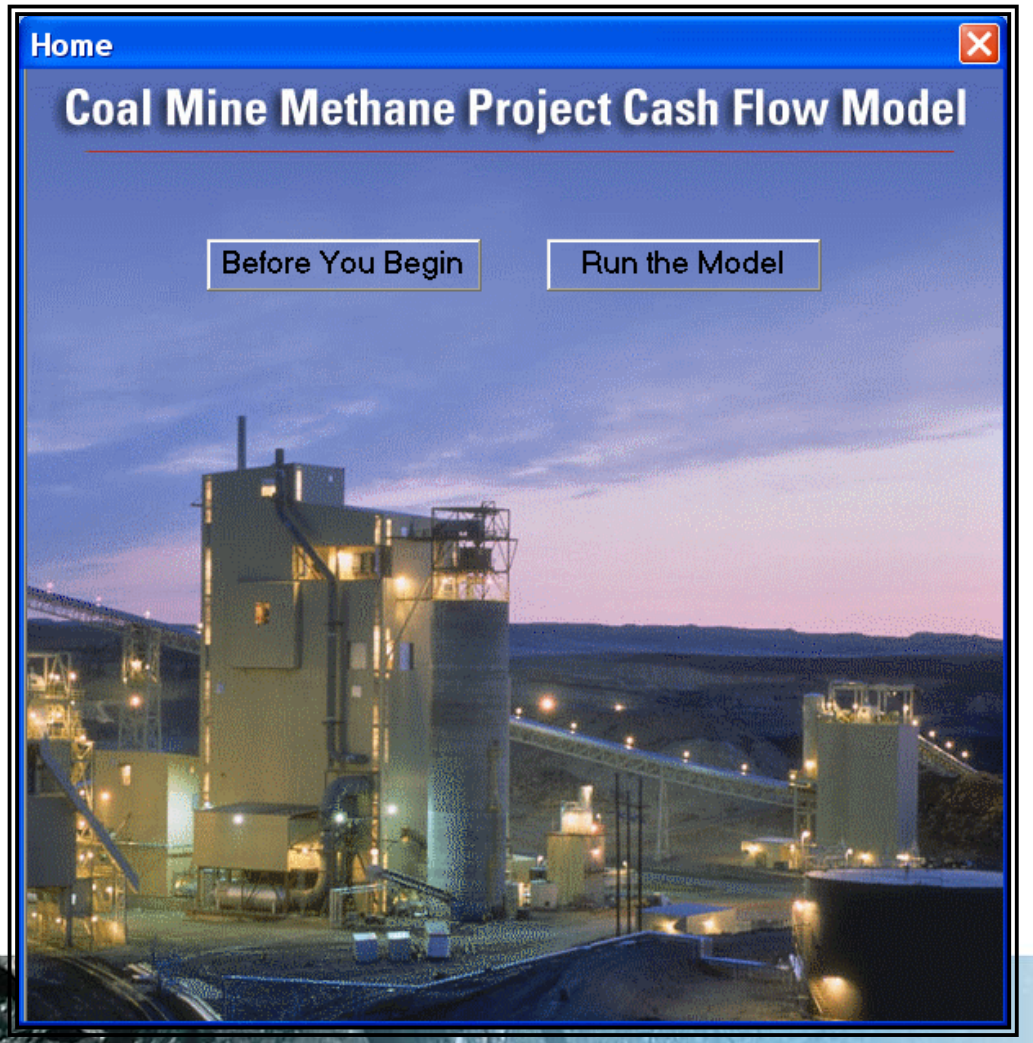
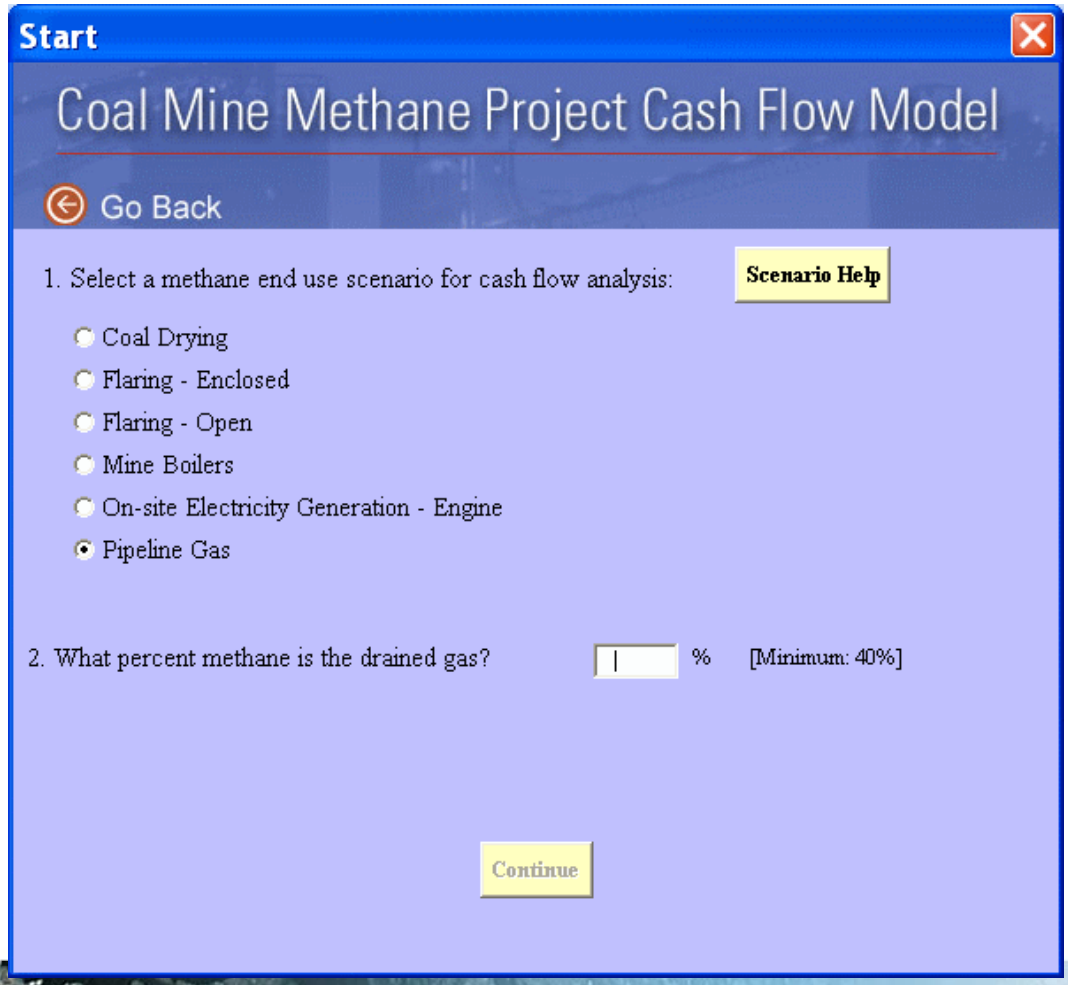
- **Coal Mine Methane Project Cash Flow Model *Beta Version***



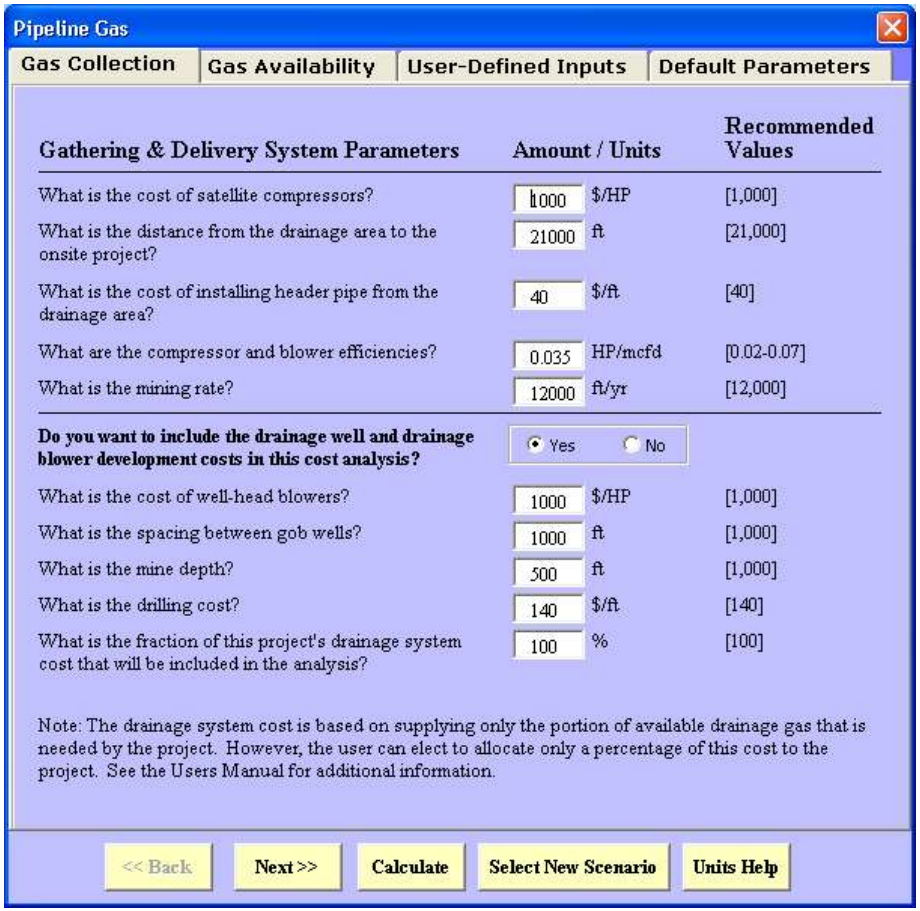
- **Model is designed to:**
  - Provide first-cut estimate of CMM project economics
  - Compare profitability of different end use options at a particular site
  - Help project developers and equipment vendors better understand their customers
- **Model is NOT designed to:**
  - Replace detailed economic analysis or feasibility study
  - Replace an in-house, site specific model

- **Choose an end-use**



Provide four (4) categories of inputs

1. Gas Collection
   - Gathering and Delivery System Parameters
   - Drainage Well Development Costs



- **Gas Collection –** estimating gathering & delivery costs
  - ➢ 100% of costs are included – no opt out

1) Gathering system (**G**) annual operating cost inputs:

Mining rate, ft/yr	(12,000 ft/yr default)
Unit cost of pipeline installed	(40 $/ft default)

G = $12{,}000\ ft \times 40\$/\ ft = 480{,}000\ \$/\ yr$

2) Compressor (**C**) capital cost inputs:

Compressor cost, $/hp	($1000/hp default)
Compressor efficiency, hp/mcfd	(0.035 hp/mcfd default)
Gas flow rate, mcfd	(no default)

C = ($1000/hp) * (0.035 hp/mcfd) * (*x* mcfd)

- **Gas Collection –** estimating gathering & delivery costs cont.

3) Pipeline (**P**) capital cost inputs:

Pipe cost, $/ft	($40/ft default)
Pipeline length, ft	(21,000 ft default)

P = ($40/ft) * (21,000 ft) = $840,000

- **Gas Collection –** estimating drainage development costs
  - Default is to exclude these costs from the analysis
  - User can decide to include a fraction of these costs

1) Gob well (**W**) annual operating cost inputs:

Well spacing, ft/well	(1,000 ft/well default)
Mining rate, ft/yr	(12,000 ft/yr default)
Mine depth, ft	(1,000 ft default)
Unit drilling cost, $/ft	(140 $/ft default)

$$\mathbf{W} = \frac{12{,}000\ ft/yr}{1000\ ft/well} \times 1{,}000\ \text{ } \times 140\$/\ \text{ } = 1{,}680{,}000\ \$/yr$$

*Selecting the default mining rate of 12,000 ft/yr and the default well spacing of 1000 ft/well results in a model-assumed well instillation rate of 12 wells per year.

- **Gas Collection –** estimating gathering & delivery costs cont.

2) Blower (**B**) capital cost inputs:

Blower cost, $/hp	($1000/hp default)
Blower efficiency, hp/mcfd	(0.035 hp/mcfd default)
Gas flow rate, mcfd	(no default)

B = ($1000/hp) * (0.035 hp/mcfd) * (*x* mcfd)

3) **F** = the fraction of the drainage system cost that is included in the CMM project cost.

- **Gas Collection -** summary
  - Annual operating cost = G + (W * F)
  - Capital Cost = C + P + (B * F)
- F is applied only to drainage development costs
- B and W can be excluded by defining F as 0
- B and W can be partially borne by the CMM project bottom line and partially by the coal production bottom line
- Assume that B and C are powered by the project CMM

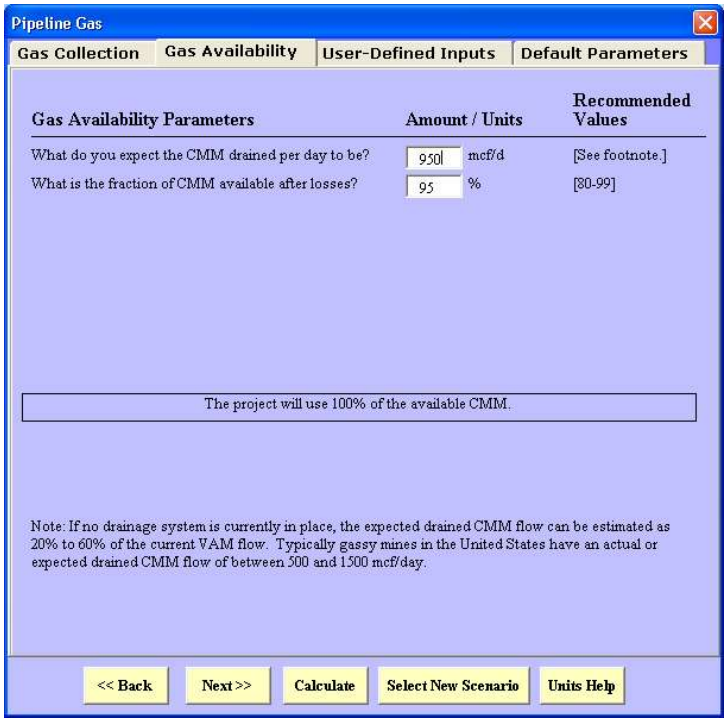
- **Provide four (4) categories of inputs**

2. Gas Availability
   - CMM drained per day
   - Some requested inputs are

   end-use specific

3. User-Defined Inputs
   - Create a Scenario Name
   - Input site-specific parameters such as

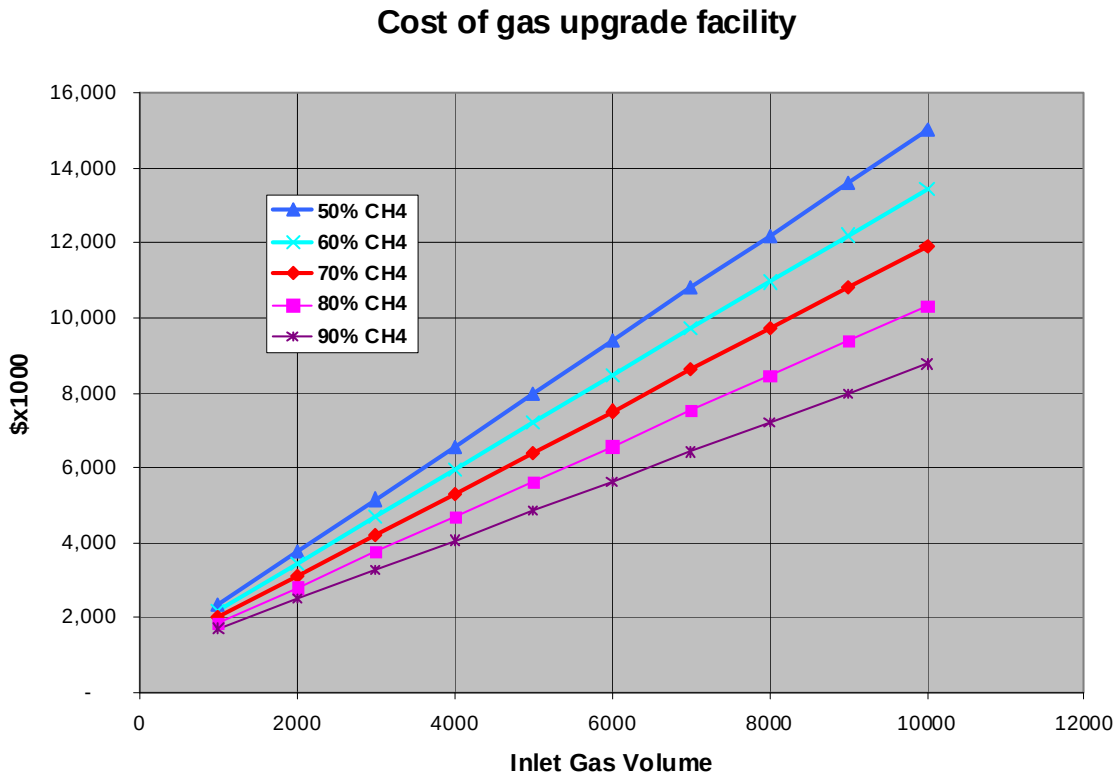
   distances, prices, equity structure



4. Default Parameters
   - Input parameters that are independent of the project such as inflation; royalty, severance tax, and negotiation fees; contingency factor.

- **Model Calculations –** Pipeline Injection

  ➢ Assume installation of membrane or pressure swing adsorption system to remove nitrogen and CO2



- **Model Calculations –** Coal Dryers and Mine Boilers
  - ➢ Model assumes existing equipment will be retrofit, so capacity remains constant during switch
  - ➢ Up to 100% of CMM will offset coal used, and any remaining demand will be met by coal
    - ie: model allows for co-firing
  - ➢ Other end-use scenarios assume new equipment is specified for available CMM volumes

- **Model Outputs**
  - ➢ CMM available for other projects – model can be rerun
  - ➢ IRR, NPV, CERs earned (tonnes/year), equity and debt requirements
  - ➢ Some inputs are repeated to inform the final analysis
    - Interest rate, discount rate, carbon credit price
  - ➢ Can generate an attractive flyer to save or print
    - Cash flow analysis bar graph
  - ➢ Can return to input screen to modify specific variables and rerun your scenario

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- **Summary –** CMOP tool available to help YOU analyze the costs and benefits of implementing a CMM use project
- **Next Steps**
  - visit CMOP booth for model demonstration
  - Get started with the User's Guide
  - Download model from www.epa.gov/cmop
  - Contact CMOP with any question, requests for assistance, or suggestions for enhancement
    - CMOPmodel@erg.com
    - Jayne Somers, 202.343.9896

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- **Model Calculations –** Pipeline Injection, cont.
  - ➢ Some methane is removed into waste stream, depending on the concentration of methane in the inlet gas